Hungry Horse
Habitat Mitigation Project
1994
annual report

PHOTO BY ESTHER HUTCHINSON

Montana Department
of
Fish, Wildlife & Parks

John Vore
Patrick R. Malta
Eric Schmidt

ANNUAL PROGRESS REPORT

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Prepared by: John Vore
Patrick R. Malta
Eric Schmidt

Approved By: Harvey Nyberg
Terry Lonner

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EXECUTIVE SUMMARY

Beginning in September 1987, Bonneville Power Administration (BPA) funded an elk / mule deer winter range enhancement project adjacent to Hungry Horse Reservoir. Two elk / mule deer winter ranges adjacent to (east of) the reservoir were selected as having potential for enhancement. These were the Firefighter Mountain winter range (Firefighter), near the dam, and the Spotted Bear winter range (Spotted Bear) at the head of the reservoir. Firefighter was selected as providing the greatest opportunity for enhancement, due to limited quantity and quality of winter forage. A long-term enhancement plan was submitted to BPA in June 1990 (Casey and Malta 1990). That plan identified 71 habitat enhancement sites (67 at Firefighter, 4 at Spotted Bear). These included 13 sites in natural shrubfields, 6 sites where understory shrubs would be slashed, and 52 sites where some level of canopy removal would be used to create foraging areas. Enhancement activities are being funded through a trust fund agreement between Montana Fish, Wildlife & Parks (FWP) and BPA. This report summarizes project monitoring through December 1994.

A marked sample of approximately 45 elk has been used to monitor the wintering elk population at Firefighter. This winter range is inhabited by approximately 140-200 elk, most of which are resident animals. Two winter herd units have been identified which are likely to benefit from the habitat enhancement efforts. The 1994 population estimate was 139±42 elk. Our estimate at Spotted Bear was 513±304.

Winter calf and bull per 100 cow ratios at Firefighter were 38.2 and 15.2 respectively in 1994. Ratios among elk observed on summer/fall range were 20.6 calves and 14.4 bulls per 100 cows. We speculate that the difference between the two time periods is due to sightability of elk. Among 25 marked reproductive-age cows 42.9% were thought to have reared calves to 6 months of age. We observed changes in the association of calves with their dams during fall. Four of 6 cows seen with calves at heel between June and October were not accompanied by calves later on. Similarly, among 8 cows that were not seen with calves between these months, 3 were later seen with calves at heel. We speculate this phenomenon is related to the energy dynamics of raising a calf and again becoming pregnant.

Two of 39 marked cows (10%) at Firefighter were legally harvested during the report period. There were no mortalities among 6 marked bulls.

We constructed survival curves for South Fork elk by combining Firefighter and Spotted Bear for all years. Based on the fates of 70 cows, survival is 88% annually. Forty-seven percent of mortality was legal harvest, 10% poaching or wounding loss and 43% other causes (winter kill, predation, unknown). Among 19

bulls, 92% did not survive to 36 months from date of marking. Hunting accounted for ≥85% of mortality.

Fecal pellets collected during winters of 1988, 89 and 91 were analyzed for food habits. Eighty-six percent of diet was shrubs and conifers. Oregon grape and Pacific yew together made up 39% of diets.

Urine urea nitrogen to creatine ratios (UUN:C) have been used to assess the nutritional status of big game herds. We collected urine in snow on 4 winter range areas periodically from January through March. Through late February, 3% of 95 samples had UUN:C ratios ≥3.8, indicative of severe nutritional deprivation. In mid-March, it was 13.9% of 36 samples. These data will serve as baseline for evaluating the efficacy of our habitat enhancement.

Indices of habitat use based on pellet-group data continue to show heavy use of natural openings as compared to forested habitats. Use of proposed enhancement sites (timber sale units) averaged well below random forested sites based on pellet-group data, indicating such sites are currently under-utilized by elk.

Data collection and analysis for the Spotted Bear winter range continues to be de-emphasized as Firefighter receives the focus of enhancement (and therefore monitoring and evaluation) efforts.

Vegetation monitoring efforts focused on treatment areas at Firefighter during 1994. Browse-utilization transect data indicate preferred browse species are generally in poor condition in natural openings used by elk, and are present as a minor component of the shrub layer in timbered sites scheduled for treatment. Serviceberry, willow, redstem ceanothus, maple and rose continue to be preferred species where available. Preliminary analysis of vegetation response to treatment (slashing and burning) in 3 natural openings suggest that the relative abundance of plants did not change, browse use went up, and annual growth of leaders increased by 224, 124 and 90 mm.

In FY95 population monitoring will include continued efforts to increase the sample size of marked elk at Firefighter and restore an adequate sample size at Spotted Bear. We will continue to collect data for mark/resighting estimates and to develop a sightability model. Approximately 40-50 pellet-group surveys will be conducted annually to monitor elk distribution and habitat use relative to enhancement sites. Monthly pellet samples will also be collected during winter months to determine seasonal food preferences at Firefighter. Twenty or more treatment and control sites will be sampled for vegetation response on an annual basis using the USFS ECODATA Ocular and Short Nested Microplot methods. Additional browse transects will

be conducted to monitor utilization and vigor of preferred browse species.

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INTRODUCTION

Portions of two important elk (*Cervus elaphus*) winter ranges totalling 8,749 acres were lost due to the construction of the Hungry Horse Dam hydroelectric facility (Casey et al. 1984). This habitat loss reduced the carrying capacity of these winter ranges by an estimated 175 elk, and the loss of 3,844 acres of upland shrub habitat on these winter ranges also lowered carrying capacity for mule deer (*Odocoileus hemionus* (Casey et al. 1984). The Hungry Horse wildlife mitigation plan (Bissell and Yde 1985) identified habitat enhancement on currently-occupied winter range as the most cost-efficient, easily implemented mitigation alternative available to address these large-scale losses of winter range. The Columbia Basin Fish and Wildlife Program, as amended in 1987, authorized BPA to fund winter range enhancement to meet an adjusted goal of 133 additional elk.

The advance design phase of the BPA-funded project was initiated in September 1987, and included detailed literature review, identification of enhancement areas, baseline (elk population and habitat) data collection, and preparation of 3-year (Casey et al. 1988) and 10-year (Casey and Malta 1990) implementation plans. Results of initial data collection were summarized in previous annual reports (Casey and Malta 1990, 1991, 1992; Vore and Malta 1994). A site-specific habitat and population monitoring plan, which outlined our recommendations for evaluating the results of enhancement efforts against mitigation goals, was also prepared (Casey and Malta 1990b). This annual report summarizes results of the project efforts during the period 1 October 1993 - 30 December 1994.

The scope and objectives of this project directly address the management goals and concerns for elk and mule deer in FWP administrative Region 1 (Mussehl et al. 1986). Regional goals include improving elk habitat, increasing elk numbers, and seeking mitigation for habitat destroyed by federally-funded development projects. Public ownership of key habitats, consideration of habitats as land uses intensify, and provision of a diversity of hunting opportunities are all designated as important regional FWP concerns. Implementation of this mitigation effort has been identified specifically as an elk management strategy to be emphasized in our statewide elk management plan (MDFWP 1992). The project also directly complements big game winter range management efforts on the Hungry Horse and Spotted Bear Ranger Districts of the Flathead National Forest (USDA Forest Service 1985).

The primary responsibilities of the FWP project personnel have been to develop and implement the population and habitat monitoring effort. Enhancement activities are being conducted by personnel employed by or under contract with the Flathead

National Forest and are funded with interest from the wildlife mitigation trust fund.

Historical data summarized by Casey et al. (1984) indicated that elk populations have fluctuated between 1000-1500 in the valley of the South Fork Flathead River (South Fork) outside the wilderness, with the majority wintering on the Dry Parks portion of the Spotted Bear winter range (Biggins 1975). Prior to this study, estimates based on annual surveys (FWP file data) indicated a current population of 500 - 1000 at Spotted Bear, and 50-100 on and around Firefighter Mountain. These two big game winter ranges adjacent to Hungry Horse Reservoir were selected for initial enhancement activities.

STUDY AREA(S)

FIREFIGHTER

The Firefighter Mountain winter range (Firefighter) is on the northeast end of the reservoir (Fig. 1). Firefighter was selected to be the focal area for initial enhancement efforts, because it presented the greatest opportunity for improvement. Though dominated by fire-caused shrubfields when the dam was built, the Firefighter area is now primarily forested, as conifers have gradually encroached into the openings. These dense seral lodgepole pine stands have limited value to elk. Today, only about 200 acres of natural open areas remain on Firefighter, with openings typically less than 30 acres in size. We assumed that the low wintering population at Firefighter is a result of this habitat condition, with forage availability playing an important role in limiting the population.

As defined for this project, this winter range comprises approximately 28,160 acres. Enhancement activities were limited to an area approximately 7000 acres in size in the core of the winter range.

SPOTTED BEAR

The Dry Parks / Spotted Bear winter range (Spotted Bear) lies at the southeast end of Hungry Horse Reservoir, and encompasses a portion of the South Fork drainage above the reservoir, as well as the lower portion of the Spotted Bear River drainage (Fig. 2). As defined for this study, the winter range is bounded on the west by the reservoir and the South Fork, and on the east and south by wilderness boundaries, comprising approximately 45,000 acres.

The southern portion of the Spotted Bear winter range is primarily forested. The Dry Parks area, on the other hand, is dominated by fairly steep western exposures with very large

shrubland areas interspersed with smaller patches of timbered habitat.

PROJECT GOALS AND OBJECTIVES

The primary goal of the project is to increase habitat diversity and therefore elk carrying capacity in currently occupied winter range areas through habitat enhancement. Specific goals include creation of foraging habitat (openings of <=20 acres) in areas where natural succession has caused dense forest to replace seral shrubfields; and rejuvenation of existing, shrub-dominated openings through prescribed burning. We hope to increase habitat quality / availability for mule deer by incorporating their habitat needs into the design of habitat treatments planned primarily for elk, (e.g. providing additional spring range areas through the creation, treatment or expansion of openings).

An additional, essential project goal was to design and implement an intensive population monitoring program which would allow assessment of population responses to habitat treatment. Specifically, our goals were to: 1) determine bounded estimates of baseline elk populations using the two winter ranges; 2) design and implement surveys to monitor populations through estimation of population size and dynamics; 3) determine baseline patterns of distribution within winter ranges; 4) design and implement surveys to document changes in distribution over time; 5) determine baseline and post-treatment patterns in habitat use and food habits; and 6) design and implement systematic surveys to monitor changes in habitat use.

The primary goals of our habitat (vegetation) monitoring program are to describe baseline habitat condition, and design and implement a vegetation monitoring system which allows determination of habitat responses to treatment. Site-specific monitoring goals were to: 1) determine the species composition, condition, and utilization of browse forage species in treatment and control sites, and 2): determine species composition, density, cover values of dominant and subdominant plant species, and forage production in treatment areas, before and after treatment.

METHODS

POPULATION MONITORING

Baseline population and habitat data collection began during late fall, 1987. Marked elk have been used to determine current distribution and seasonal use patterns. Population monitoring has concentrated on establishing baseline information, and on

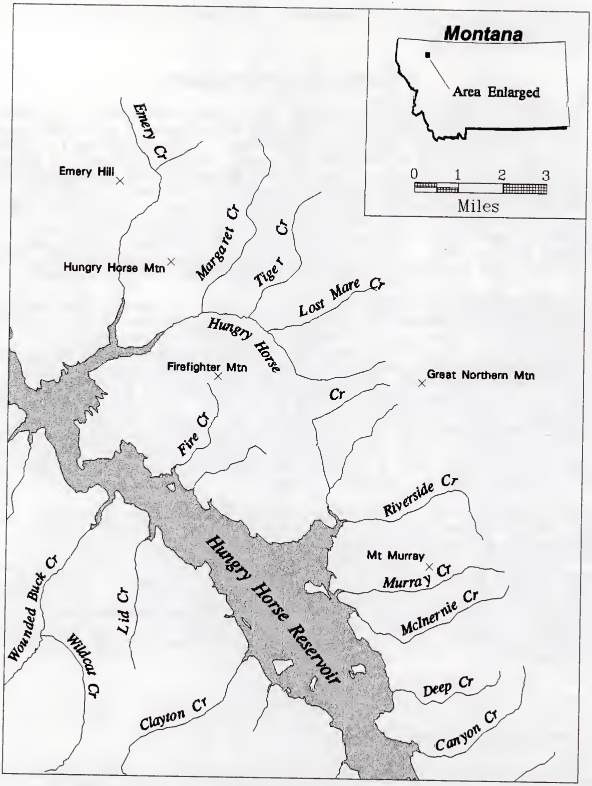

Figure 1. Map of the Firefighter Mountain project area adjacent to Hungry Horse Reservoir, northwest Montana.

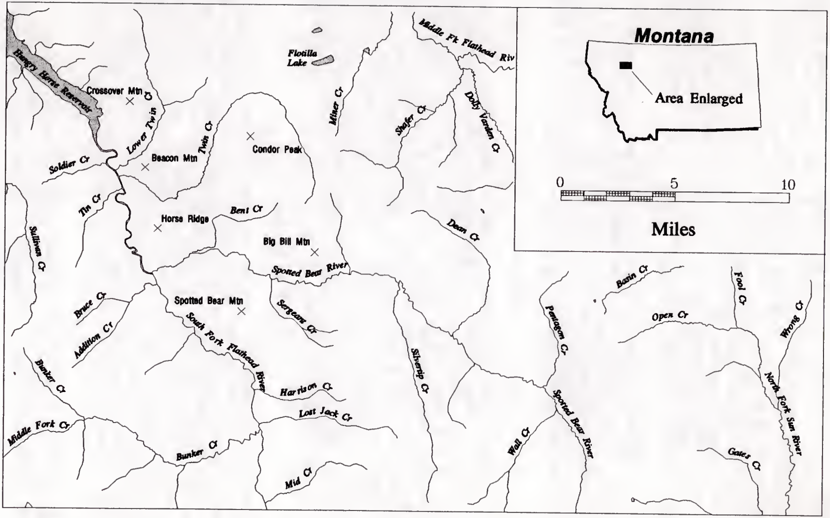

Figure 2. Map of the Spotted Bear project area adjacent to Hungry Horse Reservoir, northwest Montana.

testing methods for assessing response to pilot habitat treatments. We determined, and will maintain, a marked sample size (>45 elk at Firefighter) adequate for determining population estimates accurate to within $\pm$10 percent with 95 % confidence (Rice and Harder 1977). In order to improve the efficiency of future monitoring efforts, we have collected detailed sightability data. The original estimate of 25% observability for fixed-wing surveys of this herd, developed by Biggins (1975), was tested using a double aerial sampling scheme similar to that developed in Idaho by Samuel et al. (1987). This method assesses observability (sightability) as a function of group size, canopy coverage, and other factors (Samuel et al. 1987).

Fieldwork, data collection and analysis for the report period concentrated on: 1) attaining a marked sample of >45 elk at Firefighter; 2) gathering enough aerial survey data to refine baseline population estimates; 3) building the database needed for a sightability model, and 4) Winter collection of elk feces and urine for monitoring of elk diets and condition.

Trapping

Elk were captured by net-gunning from a helicopter during the report period. This differs from previous years when elk were captured in corral or Clover traps. Sex of trapped animals was determined by the presence/absence of antlers and/or inspection of the genitals. Age was estimated by incisor eruption and wear (Quimby and Gaab 1957). Some elk were marked with standard, others with mortality-sensing, single-pulse radio-transmitter collars. Radio-collars were also equipped with color-marked neckband material for individual recognition. All marked elk were also marked with large yellow stock-tags in each ear to increase observability. These were individually numbered as a further means to identify individual animals.

Population Surveys

Aerial (fixed-wing) surveys were the primary method used to collect population data. We attempted to conduct aerial surveys of both winter range areas at least twice monthly during Sept.-May, and at least monthly during the summer. During each survey, we recorded the location, number and general habitat type of each elk or group of elk. Visual confirmation of radio-collared animal locations, and classification (age/sex) data were collected whenever possible. All relocations were mapped on 7.5 minute USGS topographic maps. Population indices were calculated almost entirely from aerial survey data, though sign survey data were also used to indicate trends.

We made an intensive effort to classify elk on summer range. Elk were classified as cow, calf, spike, raghorn, or branch-antlerd bull. We classified marked, reproductive-age cows observed as:

"with calf", "likely with calf", "unknown", "likely no calf" and, "no calf". For example, in 1993 cow 5319 was seen in the company of two other cows and 2 calves on 1 September. On 17 September she was seen alone with a calf, and on 1 October was observed suckling a calf in the company of 2 other cows and a raghorn bull. Hence we considered her "with calf". Likewise cow NBWAV was observed alone on 5 August, but on 1 September was seen walking across a large, open flat near the head of McInernie Creek accompanied only by a calf at heel.

"Likely" catagories included elk we were less sure about such as those seen in mixed groups and/or only observed once. For example, cow 5042 was seen in a group made up of 4 cows and 3 calves, and again in a group of 8 cows and 5 calves and was considered "likely with calf". Conversely, those put in the "likely no" catagory were either seen only once without a calf, or seen in groups with low (≤0.4) calf:cow ratios.

During winter elk were classified in the same manner as during summer. A final winter estimate of calves and bulls:100 cows was arrived at by considering first only those flights in which ≥25 cows and calves were observed. Final estimates and 95% confidence intervals were then the mean ± 2 standard errors of individual flight estimates.

Distribution / Habitat Use

Long term trends in distribution and habitat use by elk and deer are being monitored within and around the treatment areas, particularly to determine if increased use over time indicates an actual population increase or merely a shift in distribution. The locations of all elk and mule deer (groups) seen within the project area were mapped to describe current seasonal distribution and habitat use patterns within each winter range. Composite maps of the number of elk group locations by UTM block were developed for Firefighter, to display seasonal patterns in distribution. A location was defined as an elk group of any size, located either visually or by radio receiver. Hence a single, unmarked elk was weighted equally with a group of 10 elk including three marked animals. This removed part of the bias caused by low sightability and interactions of marked animals. Calving areas and other important seasonal use areas were identified through plotting of digitized radio-location data, and through the seasonal elk group density maps. Distribution and juxtaposition of winter home ranges were useful for identifying important segments of the Firefighter winter range, and for delineating herd unit boundaries.

Multiple Mark-Resighting Estimates

Mark-resighting estimates (Rice and Harder 1977) were developed from aerial survey data. Our goal was to gather enough data using marked animals to generate 95% confidence intervals of ±10% around

our mean population estimates. Mark-resighting estimates were developed from 7 double-sample flights and 1 helicopter survey flight at Firefighter. A recapture (resighting) was defined as a visual relocation of a marked animal. Adjustments were made for marked animals known to be outside the area intensively surveyed, and for known emigration and mortality.

Sightability Model Development

Aerial surveys conducted during winter (15 Dec. - 15 May) were designed to provide data which could be used to develop a sightability model (after Samuel, et al. 1987). Two complete passes over the winter range were conducted during each such flight. The radio receiver was not used during the first pass, and all elk seen were classified (when possible) and counted. General canopy coverage class (0-5, 5-25, 25-50, 50-75, 75-95, 95-100 percent), group size, and activity were noted for each group. Any marked animals seen during the first pass were noted, and individually identified when possible. During the second pass, we searched for radios using a receiver, recording all data as described for the first pass. Sightability values were then defined as the percent of groups containing radio-marked animals (within the study area), which were seen during the first pass.

Data from double-sampling surveys will be used to develop sightability curves (models) based on canopy coverage and group size, for each winter range segment (herd unit). These variables were found by Samuel et al. (1987) to be the most important variables determining sightability of elk in an Idaho study area. Sightability values were calculated for known-size groups containing marked elk, as described for all groups. (For example, if marked elk were present in groups of 7 elk on 10 occasions, and these groups were seen during the first pass on 5 of those occasions, sightability for that group size (7) was 0.50 or 50 percent.) Linear and/or exponential regressions will be run to examine the relationship between sightability and group size (and canopy cover class).

The double-sampling data also provided an opportunity to calculate mark-resighting estimates free of the bias caused by intensive efforts to see marked (radio-collared) animals. Only first pass data were used for mark-resighting estimates.

All animals seen during aerial surveys were classified by age class and sex. These classification data are used to supplement other trend data in the South Fork as part of the Region's elk management program. Population age structure was also determined from the trapped sample and from elk harvested by hunters based on tooth eruption and wear (Quimby and Gaab 1957).

Pellet-Group Transects

Habitat conditions and elk use patterns were assessed in part through the use of pellet-group / browse utilization transects. Loft and Kie (1989) showed that pellet-group transects accurately reflect deer habitat use during seasonal use periods. This effort served as a pilot study to determine the number of transects necessary to adequately describe habitat use. Because of the large number of transects needed to accurately estimate population size based on pellet-group data (Neff 1968), population estimation was not an objective. Cursory estimates were developed for comparison to aerial survey data.

Pellet-group strip transects were established in proposed treatment sites, adjacent control sites, and at a set of random locations stratified by elevation, aspect and canopy coverage class (Casey and Malta 1990b). Sixty potential (random) transect sites were selected in the Firefighter winter range, and subsets of 13-15 of these random points were sampled during each year that pellet transects were run. Stratification allowed for analysis of pellet group (elk) densities based on these variables (elevation, aspect, canopy cover class) for use in planning efforts. Pellet-group transects were run at least once (1-4 times) at each of 15 proposed treatment sites and 7 additional control sites during the baseline report period.

Transect sites were permanently marked with a metal fencepost and are hereafter referred to as "monitoring sites". Transects were 250 m long, with starting points permanently marked (Fig. 4). All pellet groups within 2 m on either side of the center line were counted and cleared. Total area sampled on each transect was 1000 sq m, or 0.1 ha (0.25 acres). The approximate age, and species were recorded for each pellet group. We defined winter as the period 15 Dec. - 15 May. Only those groups classified as "new", "moderately new" or "fresh" (if prior to 15 May) were used to calculate elk and deer-use estimates. Pellet-group age classification was subjective, and was based on color, texture, cohesiveness and site characteristics. Through such classification and clearing the transects, we hoped to reduce the error due to mis-classification of pellet-group age (Van Etten and Bennett 1965).

Food Habits

Food habits of elk were determined by microhistological examination of fecal samples collected on winter range. A sample consisted of 3 pellets from each of 20 pellet groups. These were frozen for later analysis by the Habitat Labortory at Washington State University in Pullman. Fresh (≤ 72 hrs old) samples were collected bi-weekly from January through March at each of 4 winter range areas: Firefighter North, Firefighter South, Spotted Bear Dry Parks, and Spotted Bear remainder.

Elk Nutrition and Condition

We monitored elk nutrition through determination of fecal nitrogen and diaminopemelic acid (DAPA) in elk feces (Nelson et al. 1986). Fecal nitrogen is an index of protien in the diet. DAPA is an amino acid produced by microfauna in the rumen and, unlike many other microbial byproducts, is not taken up by the elk. Hence a higher nutritional plane for the elk results in higher DAPA levels in feces because of increased micorbial numbers and activity. Fecal samples for nutritional analysis were collected in the same manner and from the same pellet groups as those collected for food habits.

Elk condition was monitored by determining urea nitrogen:creatinine (UUN:C) ratios from urine in snow (DelGiudice and Seal 1988; DelGiudice et al. 1991a,b). The most concentrated portion of each urine deposit was collected in plastic sandwich bags (most often about ½ a bag), frozen, and sent to the Veternary Research Laboratory in Bozeman, Montana for analysis by spectrophotometry. We tried to collect 12 samples of snow-urine at the same sites and times that pellet collections were made. This facilitated correlations between diet, fecal nitrogen, fecal DAPA, and urine UUN:C ratios.

VEGETATION MONITORING

Browse-Utilization Transects

Browse-utilization transects (Cole 1959, Stickney 1966) were used to describe the species composition and condition of shrub species at random, treatment and control sites. Transect methods were described in detail in our FY90 annual report (Casey and Malta 1990b), and involve taking measurements at 50 shrubs along a 125-m transect (Fig. 4). Browse utilization data were collected at 14 stratified random sites during either 1988 or 1989, 13 treatment and 4 control sites during 1991, and at 10 treatment and 4 control sites during 1992. Relative abundance of shrub species was calculated as the percent of 50 shrubs measured at each site. Browse utilization was estimated by calculating the mean percent (number) of twigs browsed (Stickney 1966) for shrubs of a given species encountered at each site. An index of shrub vigor was developed for each species sampled by averaging the mean length of the previous year's annual growth on 5 randomly selected shoots for up to 25 individual shrubs per transect. A comparison of pre- versus post-treatment huckleberry twig length was done with Student's t on data transformed to its natural log (Zar 1974).

Browse transect data were used to describe baseline conditions at individual monitoring sites, primarily pre-treatment conditions at proposed enhancement sites. Pooled data for certain types (e.g. natural openings, timber sale units, random sites) were used to

identify patterns of browse distribution, abundance, and utilization, but it should be recognized that these sites were not true replications.

ECODATA Plots

We selected standardized methods from the USFS ECODATA handbook to collect detailed vegetation data from browse transect sites in treatment and control sites (Casey and Malta 1990b). These methods provide data compatible with other USFS projects, and the data sheets, methods, and analysis software are all in place at the USFS District level. Ocular plots with a 37-ft diameter were used to describe general vegetation characteristics at each of the sites (Fig. 4), and the short nested microplot method (ECODATA handbook) was used to describe species composition, density, and production in detail. This method is designed to assess such changes statistically, through the determination of the nested rooted frequency of selected plant species. This method is particularly well suited to monitoring changes over time as a function of management activities, for a selected group of species, and results in estimates of ground cover, biomass by life form (production, optional), species composition, nested rooted frequency, foliage canopy coverage, and density (optional) for those species selected. We used the optional method for production, since this variable will serve as an important measure of enhancement success. This involved clipping and weighing (gm) part or current annual production on each microplot to develop estimates of grass, forb and shrub production for each site sampled. At each site, we recorded data for preferred and dominant forage species, including shrubs, grasses and forbs. Plots were run at the permanently marked browse transect sites (Fig. 4). Five, 20x20 in. microplots were sampled along each of five, 66-ft transects randomly spaced along and perpendicular to the baseline (browse transect). ECODATA plots were established at 11 treatment sites and one control site.

Photo-Documentation

Photos were taken at selected treatment and control sites in order to document habitat changes over time. At least 3 photos were taken at the permanent monitoring site markers (fenceposts) in the following sequence: A) looking down the transect from the fencepost; B) looking back toward the fencepost from a point 10 m along the transect (the opposite direction from A), and C) looking into the treatment unit from point B, in the direction(s) best representing the features of the stand (Fig. 4). The date, site and azimuth of each photo were recorded on a board in each photo. No cover board was used, so these photos were used for qualitative purposes only.

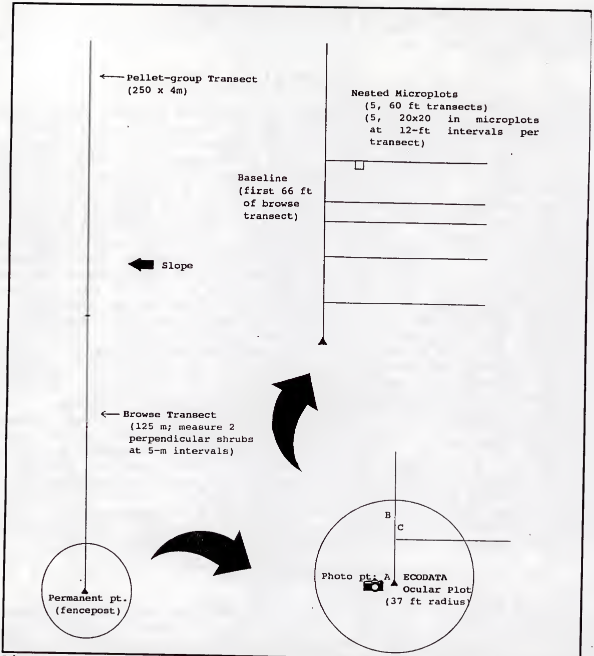

Figure 3. Configuration of monitoring site pellet-group and browse utilization transect, ECODATA plot, and photo-points, Firefighter.

RESULTS AND DISCUSSION

POPULATION DATA

Trapping

We captured 19 elk, including 8 at Spotted Bear and 11 at Firefighter, using a netgun fired from a helicopter on Dec. 14, 15, 20 and 21, 1993. The Spotted Bear elk were 7 females (4 calves, 2 yearlings and a 2½-year-old) and a yearling male, while at Firefighter we captured 6 females (3 calves, a 4½-year-old, a 10+, and an unaged adult) and 5 males (4 calves and a yearling). There was one mortality of an adult cow during trapping. This brought to a total of 35 functioning radio collars at Firefighter and 14 at Spotted Bear. Additionally, it is assumed that there are 3 non-functional radios and 7 neckbanded elk at Firefighter, and 1 non-functional radios and 10 neckbanded elk at Spotted Bear. Making totals of 45 marked elk at Firefighter and 25 at Spotted Bear. At the end of the report period there were 43 marked elk at Firefighter (Appendix A) and 21 at Spotted Bear (Appendix B).

Population Surveys

During the report period we made 24 flights at Firefighter and 14 at Spotted Bear resulting in 752 and 130 relocations of marked elk respectively.

Distribution -Firefighter. Relocations and winter censuses show 2 distinct herd units using Firefighter Mountain. The northern unit ranges from Firefighter north to Hungry Horse and Desert Mountains in winter, and in summer some of these animals move to high elevation basins such as the heads of Margaret, Tiger, and Lost Mare Creeks (Fig. 4). Few animals from the north unit have been found south of the head of Hungry Horse Creek. A portion of the northern herd unit stay on Firefighter winter range year-round.

Elk of the southern herd unit generally spend winter south of Firefighter Mountain near the mouths of Murray and McInernie Creeks. In summer most of the south unit elk move up in elevation and can be found at the heads of drainages from Riverside to south to Canyon Creek (Fig. 5). During winter the two herd segments remain nearly autonomous and are separated by the Dudley Creek and "Greenslope" area on the south side of Firefighter Mountain (Fig. 6).

Distribution - Spotted Bear. While we have de-emphasized work at Spotted Bear, some data were collected. With the exception of a "resident" herd that remains year-long in the vicinity of Spotted Bear Mountain, most of these animals move into the Great Bear and Bob Marshall wildernesses during summer. One cow (5127) summered in the North Fork of the Sun River and spent one of the 3 winters that we followed her there. Both she and a neckbanded cow which emigrated to the Firefighter population moved as 2 year olds.

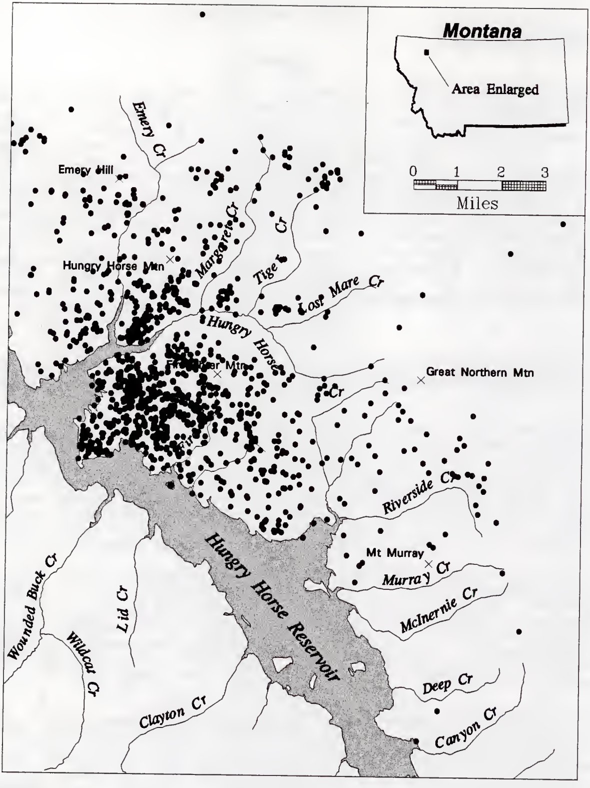

Figure 4. All elk relocations from the north herd unit on Firefighter Mountain, 1988-1994.

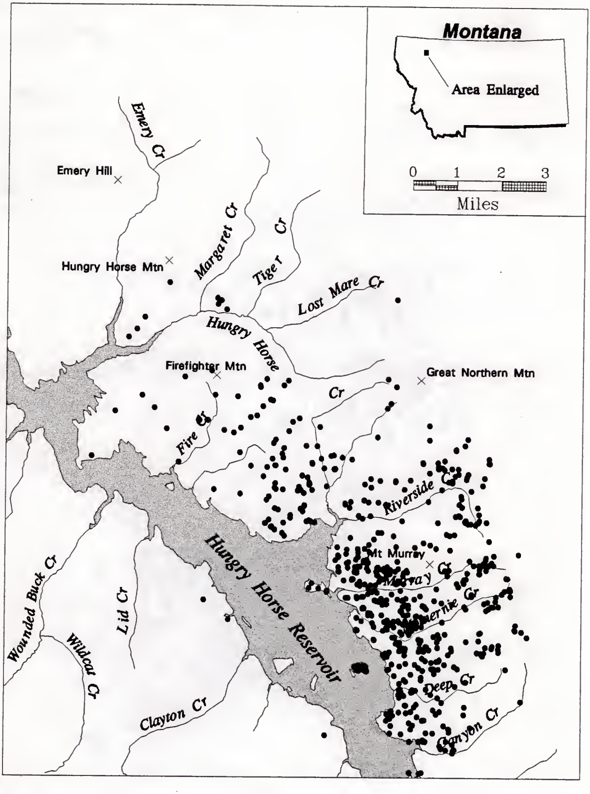

Figure 5. All elk relocations from the south herd unit on Firefighter Mounatin, 1988-1994.

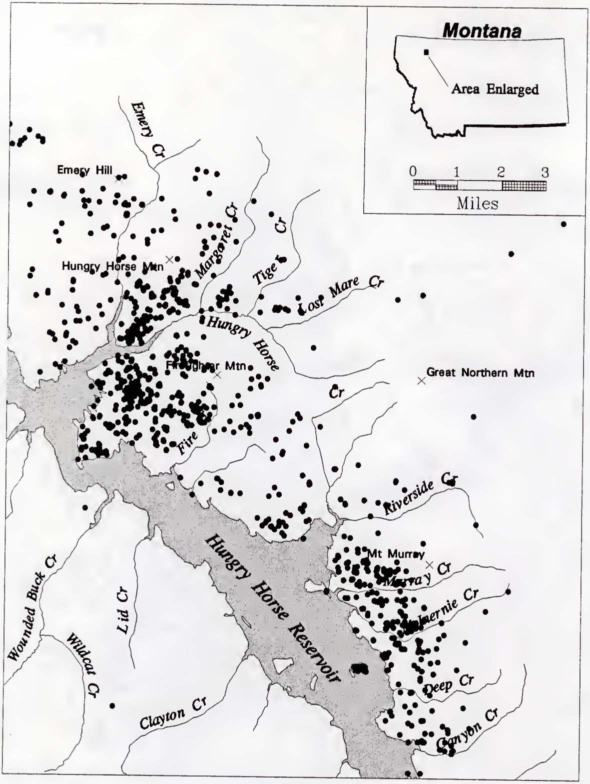

Figure 6. Winter (December 1 - March 15) relocations of radiomarked elk on Firefighter Mountain project area, 1988-1994.

Population Structure

Monitoring of population structure through classifications is important in determining productivity and one way in which we can evaluate the efficacy of our habitat enhancement efforts. Moreover, year-round classifications help us evaluate sesons and localities (i.e. winter range, summer range) of mortality, especially among calves.

We spent some time evaluating the best way to analyze calf and bull:100 cows ratios. Calf production and survival in maritime-influenced, west of the divide Montana habitats are difficult to measure. Classifications by air or ground typically used in other habitats prove inadequate because here elk density is low, groups are small, they prefer heavy cover, and classification sample sizes are low. Elk density on the Firefighter winter range is approximtely 4.0 elk per square mile compared to 12-60 on many east of the divide ranges (Vore, unpubl. data). Consequently, locating elk to classify is difficult. Moreover, elk in small groups (≤15) may bias classifications if, as suspected, reproductive and non-reproductive cows tend to separate from each other (Casey and Malta 1992, K. Hamlin, pers. comm. Feb. 7, 1995). Elk use of heavy canopy cover also hinders classifications. Seventy four percent of 293 elk groups located by radiotelemetry were in canopy cover ranging from 26 to 75%. Only 13% of these were located without radiotelemetry (Vore and Malta 1994). Small classification samples severely lower reliability of calves:100 cow point estimates. From 1988 to 1994 the mean number of cows and calves classified during 49 winter flights at Firefighter was 39. This in conjunction with all the points noted above make confidence intervals of calf and bull:100 cow estimates too wide to determine trends (Figures 6 and 7). Therefore either aternative methodology or refinement of the current one is needed. We will continue to explore possibilities.

Summer/Fall Classifications -- We continued our efforts to classify elk during summer/fall (August through October). Our goal is to gain an understanding of population dynamics throughout the year so that the real effects of winter habitat enhancement may be evaluated.

Three of five flights (152 animals classified) at Firefighter were used in summer/fall estimates of calf: and bull:cow ratios. We estimated 20.6±2.3 calves and 14.4±10.9 bulls per 100 cows. The summer/fall calf:cow ratio for 1994 was significantly lower than the 48.6±12.2 observed in 1993 (Student's t, $p=.014$). The 1993 summer/fall bull:cow ratio was 20.6±10.2 and did not differ from the 1994 value.

At Spotted Bear we made 4 summer/fall flights wherein we observed 28.6±4.4 calves and 13.4±2.4 bulls per 100 cows. Last year we only had one flight during which we observed ≥25 elk. On that flight we

saw 52.6 calves and 31.5 bulls per 100 cows. We did not do any statistical tests on these data because of the limited sample.

Winter Classifications -- During the report period we made 8 winter (December through May) census and classification flights at Firefighter. During 5 of these we observe ≥25 cows and calves and the data were used in determining calf and bull:100 cow estimates. A total of 318 elk were classified. At Spotted Bear we made 3 flights, all of which were used for our estimates. Appendix C lists all winter classifications at Firefighter since 1987.

At Firefighter we observed 38.2±11.0 calves:100 cows during the 1993/94 winter. There has been no difference among ratios since 1988 (Kruskal-Wallis ANOVA, $p=.1714$) although point estimates have ranged from 29.2 to 46.0 (Fig. 7). Our bull:100 estimate was 15.2±8.7. Again there was no difference among ratios since 1988 ($p=.3734$) and estimates ranged from 6.6 to 23.9 (Fig. 8). At Spotted Bear calf: and bull:100 cow ratios were 29.3±2.6 and 6.8±2.2 respectively.

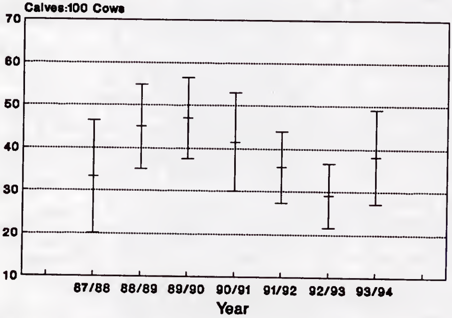

Figure 7. Calf:100 cow estimates and 95% confidence intervals for the Firefighter Mountain area, winters 1987-1994

Entire South Fork Classification -- We made a helicopter survey of the entire South Fork in cooperation with the area management biologist, Kevin Coates. The Lower South Fork from Bunker Creek to Hungry Horse dam was covered on the 26th, and the upper South Fork from Youngs and Danaher Creeks to Bunker Creek on the 27th of

April. A total of 870 elk were observed (Table 1). Calf: and bull:100 cow ratios did not differ between the upper and lower portions of the South Fork (chi square test P>.1).

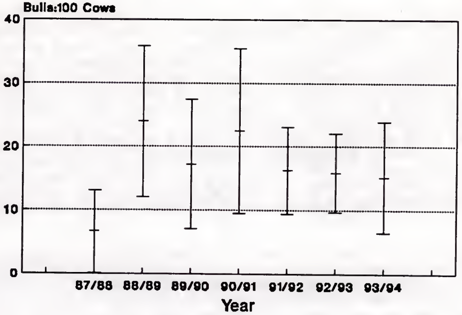

Figure 8. Bulls:100 cows estimates and 95% confidence intervals for the Firefighter Mountain area, winters 1987-1994.

Table 1. Summary of helicopter elk classifications in the South Fork of the Flathead river, 26&27 April 1994.

Location	Total	♀♀	Calves	Bulls	Unc	Per 100 ♀♀ Calves	Per 100 ♀♀ ♂♂
Lower	284	165	60	24	35	36.4	14.5
Upper	586	199	64	23	295	32.2	11.6
Combined	870	364	124	47	330	34.1	12.9

Reproduction among Marked Adult Cows -- We began trying to ascertain the reproductive status of marked reproductive-age cows as a sub-sample of all elk and one for which we could trace each cow's reproductive success through repeated sightings. This is of particular importance when addressing the survivorship of calves.

From May through December 1994 we observed 25 individual adult cows from 1 to 8 times each at Firefighter for a total of 121

observations. Fourteen cows were either "with calf" or "likely with calf", 8 were "no calf" or "likely no calf" and 3 were "unknown" (Table 2). Fourteen (63.6%) of the 22 cows not classified as "unknown" were either "with calf" or "likely with calf".

We observed changes in cow-calf associations from summer through early winter. Some cows with calves at heel during May through October were not accompanied by calves in November and December. Likewise, some cows initially unaccompanied were later seen with calves. To test our hypotheses that cow-calf associations were changing we used data from 14 cows which had been observed ≥5 times from late spring through early winter. Initally, 6 cows (42.9%) were seen with calves. Later, 4 of the 6 were not accompanied by calves. The other 2 continued associating with calves. Among the 8 observed without calves initally, 3 were seen with calves later. Among the 7 cows in which we saw changes in calf association, all occured between September 9 and November 22, 6 of the 7 after October 20.

We then wondered which calf association figure was correct. Were 63.6% of adult cows associated with calves as suggested by data where all seasons were combined, or was it 42.9% as suggested by "early" and "later" observations? To answer this we compared a model population using the above cow-calf association percentages with calf:100 cow ratios observed on winter range.

Table 2. Reproductive status of marked reproductive-age (≥3½) cow elk of the Firefighter Mountain population from May through December 1994 as determined on aerial flights. Number of times each cow was observed is in parentheses.

With Calf	Likely With Calf	UnKnown	Likely No Calf	No Calf
4112-2[a] (8)	4004-1 (7)	5172-1 (6)	5087-2 (6)	4150-3 (6)
4049-2 (7)	4130-2 (3)	5242-4 (3)	5205-2 (4)	4303-1 (5)
4194-1 (5)	5056-2 (6)	5252-1 (1)		4776-1 (5)
4271-2 (7)	5191-2 (3)			5042-1 (4)
5098-1 (4)	5282-1 (5)			5331-1 (4)
	5293-2 (8)			5377-1 (5)
	5320-1 (3)			
	5340-2 (1)			
	5391-1 (6)			

[a] Elk identification number/code.

Our model population consisted of 100 reproductive-age cows (3½ and older) and an estimated number of non-reproductive-age cows (yearlings and 2½ year olds). We estimated the latter by using the previous two years' calf:cow ratios and applying an estimated mortality rate (see "mortality" below). We assumed one half of calves are female.

If 63.6% of adult cows were associated with calves we predicted 42.6 calves per 100 cows in the winter of 1994/95. If 42.9% of adult cows were with calves, which takes into account changes in calf associations, we predicted 32.3 calves per 100 cows. The observed calf:100 cows ratio on 2 winter range surveys was 29.9. This does not differ from that predicted by the lower "change in association" value (χ^2 p=.7710) but does from that predicted by the higher (χ^2 p=.046).

In last years annual report we made note of marked cows apparently loosing their calves (Vore and Malta 1993) and speculated on reasons rangeing from visibility bias with season to predation. We had a limited data set last year because collection on reproductive status of marked cows did not begin until August. This preliminary analysis of 1½ year's data appears as though it may be useful as an additional and/or alternative method for monitoring calf production. We will continue data collection in the future.

Mortality

We predict that enhacement efforts at Hungry Horse will have beneficial effects on both the productivity and survivorship of elk. An understanding of the latter necessarily involves some knowledge of mortality factors. Also, it is important that we address the issue of increasing vulnerability to harvest through habitat enhancement and associated roads. Therefore we have undertaken to determine causes of death among marked animals. Two marked female calves at Spotted Bear were apparent victims of capture myopathy and are not included in the following discussion. Their collars were picked up in June.

Firefighter -- There were 2 known mortalities (4%) among 45 marked elk at Firefighter. Both were hunter- harvested cows. These 2 represent 5% of the 39 marked cows. There were no mortalities among 6 marked bulls (5 spikes and a 2½ year old)

Spotted Bear -- There were 2 mortalities (8%) among 26 marked elk at Spotted Bear: 1 bull and 1 cow. Both were hunter harvest. Among 24 marked cows the 1 mortality represents 4%; the harvested bull was 1 of 2 marked.

We used marked elk from both herds and all years in estimating annual survival. Among cows annual survivorship was 88% (Fig. 9).

Fifty seven percent of deaths were hunting/poaching related (Fig. 10). Known legal harvest was 47% of mortality.

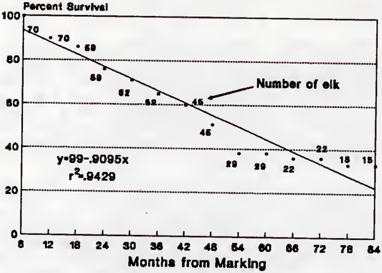

Figure 9. Survivorship from date of marking of radio-collared cow elk in the South Fork of the Flathead from 1988-1994.

Mortality rates among South Fork cows are similar to those found in other Montana herds. Hamlin and Ross (1992) noted a mortality rate of 14% among marked cows in Montana's Gravely Mountains from 1984 to 1992. Ninety percent of this (12.6%) was hunting related. In the Elkhorn Mountains of Montana from 1982-1991, DeSimone and Vore (1992) observed a 15% rate among cows with 13% (89% of the total) attributed to hunting.

Among bulls hunting accounted for a minimum of 85% of mortality (11 of 13). The cause of death of 1 bull was unknown. Twelve of 13 bulls (92%) did not survive to 36 months from date of marking (Fig. 10). The single outlier was a bull marked as an adult (4½+ years old) at Spotted Bear. He survived 68 months from date of marking and was killed by a hunter.

Mark-Resighting Estimates

We made 8 flights at Firefighter and 5 at Spotted Bear which we used for winter population estimates following Rice and Harder (1977). Our 1993-94 estimate and 95% confidence interval (c.i.) at Firefighter was 139±42 elk (Table 3). At Spotted Bear we estimated 513±304 elk (Table 4). Some of our estimates for individual flights vary slightly from those reported earlier because of

confirmations on the suspected presence or absense of neckbanded animals.

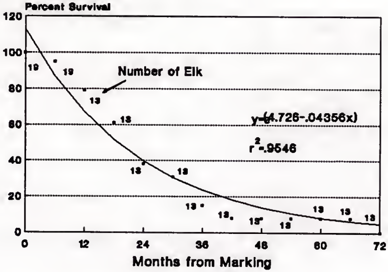

Figure 10. Survivorship from date of marking of radio-collared bull elk in the South Fork of the Flathead from 1988-1994.

Table 3. Population estimates from aerial surveys at Firefighter Mountain during January - May 1994.

Date	# Marked (M)	Total Seen (C)	# Marked Seen (R)	Observ- ability	Pop. Est.[a]
01/12/94	45	10	4	.09	100
02/04/94	45	5	0	0	275
02/16/94	45	13	3	.07	160
03/02/94	45	13	4	.09	128
03/18/94	45	66	20	.44	146
04/08/94	45	25	13	.29	94
04/27/94[b]	45	42	16	.36	115
05/14/94	45	11	5	.11	89
1993/94 mean estimate and 95% confidence interval[c] = 139±42					

[a] Population estimate=((M+1)(C+1)/(R+1))-1
[b] Helicopter survey
[c] After Rice and Harder (1977)

Table 4. Population estimates on the Spotted Bear winter range January-May 1994.

Date	Area	# Marked (M)	Total Seen (C)	# Marked Seen (R)	Observ-ability	Pop. Est.[a]
01/21/94	Dry Parks	5	59	1	.20	179
	Remainder	20	1	0	0	41
	Total					220
02/10/94	Dry Parks	5	231	2	.40	463
	Remainder	20	14	2	.10	104
	Total					568
03/08/94	Dry Parks	4	155	4	1.0	155
	Remainder	21	83	1	.05	923
	Total					1078
04/14/94	Dry Parks	6	182	4	.66	255
	Remainder	20	58	13	.62	87
	Total					342
04/26/94[b]	Dry Parks	6	105	3	.50	184
	Remainder	19	96	10	.50	175
	Total					359

1993/94 estimate and 95% confidence interval[c] = 513±304

[a] Population Estimate=((M+1)(C+1)/(R+1))-1
[b] Helicopter Survey
[c] After Rice and Harder (1977)

The 1993/94 estimate at Firefighter is higher than that of last year, but comparable with previous years (Fig. 11). There is no obvious trend in the Firefighter population. The estimate for the Spotted Bear project area is much lower than those given in previous reports (e.g. Vore and Malta 1993) because we have divided the project area there into 2 areas based on visibility in order to minimize visibility bias violations of the model.

Our 95% c.i.s were 30% and 59% of the estimates at Firefighter and Spotted Bear respectively, much higher than our 10% goal. These wide c.i.s result from variation of individual flight estimates, which, we believe, is in turn an artifact of non-random distribution of our marked sample in the populations. Due to the gregarious nature of elk and intensive, localized trapping, it has worked out that we have a high percentage of some portions of the populations marked. As an example, on the 18 March flight at Firefighter, 15 in a group of 18 elk observed were marked. This type of model assumption violation underscores the necessity for work on modifications to the present model or employing another model. We are currently working on a fixed-wing variation of the Idaho sightability model (Samuel et al. 1985). Observability of elk at Firefighter averaged 18% (range 0-44%) (Table 3). On the Dry Parks portion of the Spotted Bear project area sightability averaged 55% (range 20-100%), on the remainder of the area it

averaged 25% (range 0-62%) (Table 4). Observability increased after the middle of March, apparently because elk began using greenup in canopy openings (Tables 3 & 4). In areas with dense canopy cover (Firefighter and the "Remainder" portion of the Spotted Bear project area), sightability before elk began using openings averaged 6%. This increased significantly to 32% after mid-March (χ^2 1df=53.42, P=.0000). An increase in use of openings in early spring was also observed by Simmons (1974).

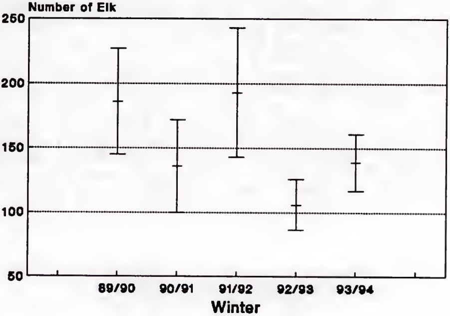

Figure 11. Population estimates on the Firefighter project area, 1988-1994.

Pellet-Group Transects

Thirty-two pellet transects were run during the report period. Since 1988, 41 pellet transects have been run from 1 to 6 times (Appendix D) at treatment, random and control points located on Firefighter. The number of new and recent pellet groups observed per transect during 1994 ranged from 0 to 19 (Appendix D). Transects in natural openings (G,J,L, and M) consistently had the highest number of groups while those in forested habitats had the least. Baseline data in treatment areas will afford the opportunity to evaluate changes in elk use following treatment.

Food Habits

In May we received some diet composition results from the wildlife habitat laboratory at Washington State University (WSU) in Pullman.

These were from fecal pellets that had been collected in 1988, 89, and 91. These were recently sent in as a comparison to diets for the same time periods previously analyzed at another laboratory. The results from WSU show a greater variety and quantity of browse species and are more in line with what we have been seeing on our browse transects.

Among 3 winter diet collections made on Firefighter during 1989 and 1991, shrubs contributed 54% and conifers 32% (Fig. 12). Oregon grape (*Berberis repens*) and willow (*Salix* spp.) togeather made up the bulk (60%) of the shrub diet while Pacific yew was 66% of the conifer diet. An April 1991 collection on Firefighter showed more grass and fewer conifers than the winter diets. This supports our observations mentioned above of elk beginning to use canopy openings in spring. Two winter collections made on the Spotted Bear project area in 1988 and 1989 suggest that elk there use slightly more shrubs, and those in wider variety (although Oregon grape and willow are still favored), and fewer conifers. In contrast to elk at Firefighter, Pacific yew was used only slightly while Douglas fir and subalpine fir made up the bulk of conifers consumed.

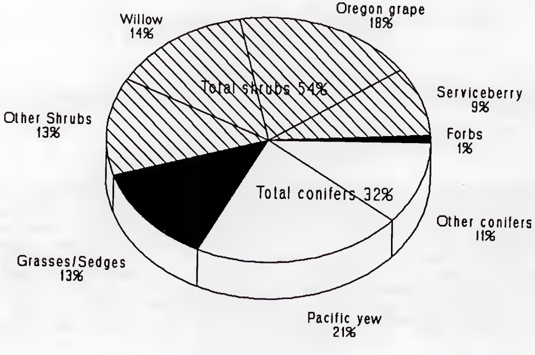

Figure 12. Winter elk diets at Firefighter Mountain 1989-1991.

Urinalysis.

The measure of urea nitrogen to creatinine (UUN:C) ratio in urine has been shown to be useful as an index of animal condition in wolves (*Canis lupus*)(Mech et al. 1987), white-tailed deer (*Odocoilius virginianus*)(DelGiudice and Seal 1988, DelGiudice et al. 1988,1989), and elk (DelGiudice et al. 1991a, 1991b). Its basis for use in northern ungulates lies in the fact that as animals suffer chronic undernutrition during winter internal fat reserves are depleted and body protiens are catabolized to meet energy demands. When this happens urine urea nitrogen values increase and can be related to creatinine values which remain stable. UUN:C ratios have been shown to vary with quality of winter range as well as over time through winter for both white-tailed deer and elk (DelGiudice et al. 1989, 1991b).

From January through March we collected 131 samples of elk urine in snow during 4 collection periods over 4 winter range areas (Firefighter north and south, Spotted Bear Dry Parks and Remainder) for determination of UUN:C ratios (Table 5). Following DelGuidice (in press; pers. comm. 11/8/94), UUN:C ratios ≥3.5 were considered indicative of sever nutritional deprivation and values approaching 24 were considered indicative of moribund elk.

We found 8 instances of UUN:C ratios ≥3.8: 1 at 3.87, 6 at 5.00, and 1 at 20.00. The latter, collected on 26 January near Spotted Bear Mountain, approaches that observed by DelGiudice and Seal (1988) among moribund white-tailed deer (UUN:C ≥23). We observed no differences between project areas during individual time periods (Jan. to mid-Feb. vs. mid-Feb. through Mar.) or between time periods on individual project areas in the percentage of samples with values ≥3.8 (χ^2 tests, P>.10). However, by mid-March 13.9% of all samples (n=36) had UUN:C values ≥3.8. This is similar to the 10.3% that DelGuidice et al. (1991b) considered a "high proportion" in Yellowstone National Park and gives us a good baseline from which to evaluate the nutritional benefits of enhancement efforts.

VEGETATION DATA

Browse Utilization

We have 36 transects which have now been sampled for 1 to 4 years. Ten transects were read during the 1994 field season. Twenty-nine browse species have been encountered on browse transects. Among these, 6 were selected for study emphasis based on high use indices (rose, maple, willow and serviceberry), known elk forage preference (redstem ceanothus), and suitability for assessing changes in the shrub community (huckleberry)(Casey and Malta 1990).

Table 5. Elk urea nitrogen:creatinine ratios from urine collected in snow on the South Fork Project areas.

Population Segment		Urea nitrogen:creatinine ratio collection dates and values			
Fire-fighter North	date	01/19/94	02/15/94		03/09/94
	n	14	5		8
	$\bar{x}$ ratio	1.48	0.64		1.90
	SE	0.22	0.05		0.49
	range	0.74-3.33	0.53-0.79		0.91-5.00
	#≥3.5	0	0		1
Fire-fighter South	date	01/20/94			
	n	3			
	$\bar{x}$ ratio	1.68			
	SE	0.61			
	range	0.48-2.50			
	#≥3.5	0			
Spotted Bear Dry Parks	date	01/26/94	02/09/94	02/24/94	03/16/94
	n	17	8	12	12
	$\bar{x}$ ratio	1.42	1.23	1.15	2.11
	SE	0.12	0.12	0.08	0.51
	range	0.55-2.60	0.93-1.85	0.69-1.61	0.58-5.00
	#≥3.5	0	0	0	3
Spotted Bear Remain.	date	01/25,26/94	02/08/94		03/17/94
	n	22	14		16
	$\bar{x}$ ratio	2.55	0.98		1.50
	SE	0.88	0.11		0.27
	range	0.28-20.00	0.38-2.00		0.43-3.87
	#≥3.5	3	0		2

We now have have 2 to 4 years of pre-treatment data for transects in forested habitats scheduled for treatment. Huckleberry typically dominated forested transects although rose was common on transects on the south side of Firefighter in lodgepole-dominated stands (transects E, F, 36, and 57 (Table 6.). Huckleberry also dominated on a thinned-larch transect (33) and among 14 random points in predominately forested habitats (Table 6). Serviceberry was the dominant shrub species in natural openings (Table 6).

Based on use indices, rose and willow are the preferred browse in forested habitats (Table 7). Redstem ceanothus was only found in low density on transects in natrual openings. However, where found it was heavily utilized.

Table 6. Pre-treatment relative abundance[a] data of selected species from browse transects, 1988-1994, Firefighter Mountain Winter Range.

Transect type and number	No. Years	Maple $\bar{x}$(range)	Serviceberry $\bar{x}$(range)	Redstem $\bar{x}$(range)	Rose $\bar{x}$(range)	Willow $\bar{x}$(range)	Huckleberry $\bar{x}$(range)
Forested[b]							
FF-A	3	0	8(8-10)	0	2(0-6)	5(2-8)	63(52-74)
FF-B(82)	4	0	1(0-4)	0	3(0-4)	0	76(70-85)
FF-C(82)	3	0	5(0-12)	0	1(0-2)	5(0-10)	70(66-76)
FF-D	3	0	6(4-8)	0	0	1(0-2)	72
FF-E(85)	3	0	2(0-4)	0	36(32-38)	0	48(44-84)
FF-F	2	0	0	0	36(32-40)	0	23(16-30)
FF-36	3	0	33(32-38)	0	15(10-22)	1(0-2)	18(18-20)
FF-54	3	0	1(0-2)	0	0	4(2-8)	73(68-76)
FF-57	2	1(0-2)	8(4-12)	0	53(46-60)	0	1(0-2)
FF-14(69)	4	0	0	0	1(0-2)	0	72(66-84)
Natural Opening[c]							
FF-G	1	0	48	8	8	0	0
FF-J	2	1(0-2)	34(30-38)	2(0-4)	8(6-10)	2	2(0-4)
FF-M	2	0	50(48-52)	4(2-6)	7(6-8)	5(4-6)	3(2-4)
Thinned Larch[d]							
FF-33	2	0	3(2-4)	0	4	4(2-6)	51(46-56)
Random Points[e]							
(n=14)	1	5(0-16)	11(0-32)	0	10(0-34)	3(0-14)	38(10-84)

[a](#plants of species/total # plants)*100 [b]Proposed timber sale units [c]Prescribed burn units
[d]Browse slashing unit [e]Mean values for random (forested) points

Table 7. Pre-treatment browse use indices[a] of selected species from browse transects, 1988-1994, Firefighter Mountain Winter Range.

Transect type and number	No. Years	Maple $\bar{x}$(range)	Serviceberry $\bar{x}$(range)	Redstem $\bar{x}$(range)	Rose $\bar{x}$(range)	Willow $\bar{x}$(range)	Huckleberry $\bar{x}$(range)
Forested[b]							
FF-A	3	--	5(0-50)	--	0 -	33(0-60)	1(0-25)
FF-B(82)	4	--	50 -	--	21(0-56)	--	2(0-40)
FF-C(82)	3	--	0	--	28 -	14(0-17)	0(1-29)
FF-D	3	--	12(3-25)	--	--	11(0-33)	1(0-1)
FF-E(85)	3	43	9(0-20)	--	48(0-100)	--	5(0-50)
FF-F	2	--	--	--	25(0-100)	--	5(0-33)
FF-36	3	--	9(0-57)	--	17(0-88)	--	(0-25)
FF-54	3	--	0	--	--	6(0-25)	1(0-40)
FF-57	2	0	31(22-39)	--	25(18-31)	--	0 -
Natural Opening[c]							
FF-G	1	--	3 -	56 -	0 -	--	--
FF-J	2	0	13(10-16)	70 -	4(2-22)	0 -	--
FF-M	2	--	12(10-13)	16(8-23)	2(0-3)	39(22-45)	--
Thinned Larch[d]							
FF-33	2	--	13(4-21)	--	3(0-60)	38(0-75)	2(0-4)
Random Points[e]							
(n=14)	1	7(0-25)	13(0-53)	--	11(0-37)	19(0-65)	7(0-31)

[a]Percent of twigs browsed (#browsed/total)*100 [b]Proposed timber sale units [c]Prescribed burn units
[d]Browse slashing unit [e]Mean values for random (forested) points

Table 8 presents data on pre-treatment annual growth among the 6 selected species. These data will be used in assessing changes caused by treatment.

Two of the forested treatment areas were cut in 1992 and burned in the spring of 1993. Timber harvest began in many remaining treatment units during summer of 1993, and some were consequently burned in the spring of 1994. Cutting on the remaining units is to be completed in 1995 and burning will be finished in 1996.

ECODATA Plot Data

No ECODATA plots were read during the report period because treatment was in process. Computer compilation and analysis of ECODATA plot data was not completed for this draft report. A list of all plant species encountered on ECODATA plots was compiled (Appendix E).

VEGETATION RESPONSE -- PRELIMINARY INDICATIONS

Enhancement work in forested habitats began the summer of 1992 and will not be completed until the summer of 1995. We therefore have few data for describing vegetation response. However, comparative data from natural shrubfields burned in spring 1991 and 1992, browse slashing units from 1991, and a random control point which fell in a previously-logged unit were available for comparison.

Natural openings G, J, and M were prescription-burned in the spring of 1991 with poor results (Casey and Malta 1992). They were slashed later in the summer of 1991 and reburned in the spring of 1992 with somewhat better yet still marginal results. Most shrub response was apparently due more to slashing than burning.

Transects in these openings provide 3 years pre- and 2 years post-treatment data. Treatment did not affect relative abundance of plants (Table 9). The effect of treatment on browse use is not readily apparent and we will need data from future years for a full evaluation (Table 9). Serviceberry was the only species encountered with enough frequency on these transects to provide for valid statistical comparisons. Browse use of serviceberry increased on transect G following treatment (chi square test, $p=.0007$) but remained the same on transects J and M ($p=.0773$ and $.6629$ respectively).

Twig length appeared to increase for all species following treatment (Table 9). Again, except for serviceberry, sample sizes were too small for analysis. Among serviceberry plants, length of previous year's annual growth increased by 124, 224 and 90 mm following treatment on transects G, J and M respectively (Student's t test, $p=.000$ for all comparisons)(Table 9).

Table 8. Pre-treatment twig length (mm)[a] data of selected species from browse transects, 1988-1994, Firefighter Mountain Winter Range.

Transect type and number	No. Years	Maple $\bar{x}$(range)	Serviceberry $\bar{x}$(range)	Redstem $\bar{x}$(range)	Rose $\bar{x}$(range)	Willow $\bar{x}$(range)	Huckleberry $\bar{x}$(range)
Forested							
FF-A	3	--	22(2-186)	--	--	144(34-379)	27(2-123)
FF-B(82)	4	--	38 -	--	75(8-170)	--	30(2-210)
FF-C(82)	3	--	3(1-17)	--	16(4-33)	68(19-183)	24(3-150)
FF-D	3	--	16(11-22)	--	--	211 -	31(24-41)
FF-E(85)	3	17(4-33)	7(2-29)	--	54(3-135)	--	37(1-215)
FF-F	2	--	--	--	35(3-135)	--	20(2-68)
FF-36	3	--	39(2-249)	--	132(157-287)	--	37(5-119)
FF-54	3	--	4 -	--	--	140 -	19(2-180)
FF-57	2	--	100(33-166)	--	84(62-106)	--	--
Natural Opening[c]							
FF-G	1	--	8 -	109 -	121 -	--	--
FF-J	2	6(3-10)	19(2-91)	--	42(9-255)	194(90-330)	19(12-24)
FF-M	2	--	21(2-211)	93(11-280)	94(6-650)	57(22-99)	19(2-42)
Thinned Larch[d]							
FF-33	2	--	--	--	16(15-18)	145(31-259)	39(37-41)
Random Points[e]							
(n=14)	1	42(16-92)	43(18-106)	--	108(26-493)	70(25-309)	39(26-62)

[a]Previous year's annual growth [b]Proposed timber sale units [c]Prescribed burn units [d]Browse slashing unit
[e]Mean values for random (forested) points

Table 9. Mean values of selected measurements of selected plants on browse transects in natural openings on Firefighter Mountain pre- (1988-1991) vs. post-slash and burn treatment, (1993-1994).

Transect	Pre/Post Treatment	Maple	Service-berry	Redstem Ceanothus	Rose	Willow	Huckle-berry
			Relative Abundance[a]				
J	Pre	1	34	2	8	2	2
	Post	0	40	1	9	1	1
G	Pre	--	48	8	8	--	--
	Post	4	35	27	12	--	--
M	Pre	0	50	4	7	5	3
	Post	0	42	0	13	5	1
			Browse Use Indices[b]				
J	Pre	0	12	70	4	0	41
	Post	17	19	80	17	67	0
G	Pre	--	2	56	0	--	--
	Post	20	14	85	43	--	--
M	Pre	--	9	16	2	39	0
	Post	--	10	--	0	8	0
			Twig Length (mm)[c]				
J	Pre	6	19	--	42	194	19
	Post	120	244	230	277	358	28
G	Pre	--	8	109	121	--	--
	Post	87	132	213	215	--	--
M	Pre	--	21	93	94	57	19
	Post	--	110	--	137	571	51

[a] (No. plants of species/total No. browse plants observed)*100 [b] (No. browsed leaders/total No. leaders)*100
[c] Previous year's annual growth of unbrowsed leaders

STATUS OF ENHANCEMENT ACTIVITIES

Enhancement activites at Firefighter include timber harvest, slashing and burning of unmerchantable trees, prescribed burning in natural shrubfields, and slashing browse in previously tinnned forest stands (Casey and Malta 1990c). There have been a few changes in treatment prescriptions since the 1990 planning. Unit 49 was originally slated for harvest but was not sold so will be slashed. Unit 57, originally slated for slashing and burning was purchased as a post and stake unit. Fig. 13 shows distribution of treatment units on Firefighter Mountain.

TIMBER HARVEST

Forty two forested units (24 as sawlog and 18 as stake and post) on Firefighter totaling about 573 acres were slated for harvest. To date 25 have been harvested including 14 sawlog units and 11 stake and post (Appendix F). Of these 25, treatment has been completed with post-harvest burning on 7 units. Burning on the remaining units is schuduled for spring 1995.

PRESCRIBED BURNING

Eight of 9 natural shrubfields slated for prescribed burning were completed by the end of the report period. The remaing one, unit 11, was combined with unit 62, a forested stand surrounding unit 11. They were slashed in the summer of 1993 and will be burned in the spring of 1995.

BROWSE SLASHING

Six of seven units scheduled for slashing have been completed. Four were slashed in 1991, 2 in 1993 and the remaing one is scheduled for treatment in 1994-96.

SLASH AND BURN

Eight of nine units scheduled for slashing and buring were slashed during the summer and fall of 1993. Burning on these units is slated for completion in the spring of 1994. The remaining unit (unit 01), is in the sale's grizzly bear subdivision where activities are scheduled for 1995-96 and treatment is slated during that time.

FY 95 PLANNED ACTIVITIES

MONITORING

We will continue with all aspects of monitoring as outlined previously. However, changes and additions to project activities are discussed below.

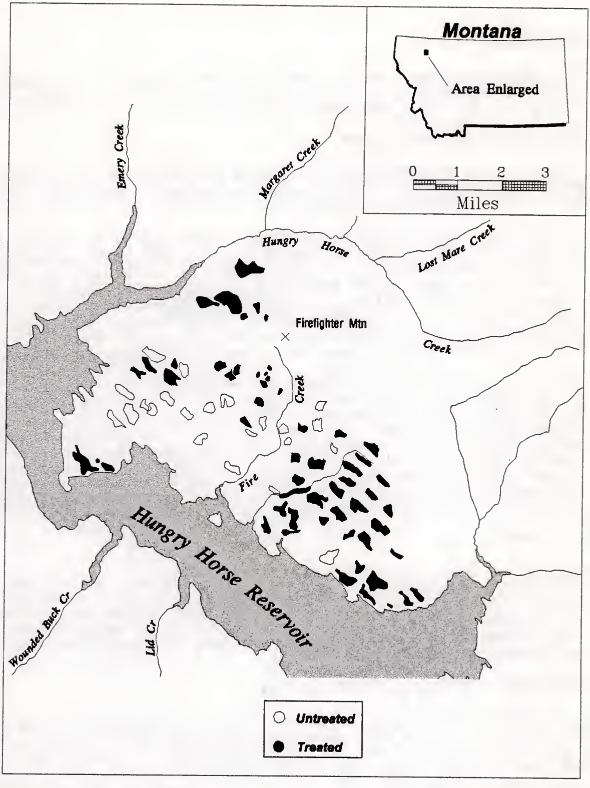

Figure 13. Location and status of treatment areas on Firefighter Mountain.

TRAPPING

Net gunning proved time and cost effective and we will again be using it during the winter of 1994/95 to maintain our sample sizes at both Firefighter and Spotted Bear.

FOOD HABITS AND NUTRITION

We will continue collecting pellets at both Firefighter and Spotted Bear in order to further define and/or assess changes in elk food habits with enhancement activities.

Because it is hoped that enhancement activities will increase both the quantity and quality of forage it is necessary to quantify the changes in elk nutrition. We will continue to collect information on the winter nutritional status of populations. We will do this through analysis of nitrogen and diaminiopemelic acid (DAPA) in elk feces (Nelson et al. 1986), and by determination of urine urea nitrogen:creatinine (UUN:C) ratios in elk urine (DelGiudice and Seal 1988, DelGiudice et al. 1991, DelGiudice et al. 1991b).

DAPA is an amino acid produced by microfauna in the rumen and, unlike many other microbial byproducts, is not taken up by the elk. Byproducts such as DAPA increase with increasing microbial activity in the rumen. This activity increases with increasingly favorable nutritional condition of the host (in this case elk) and is less as condition decline. Therefore, relative levels of DAPA can be used as an index of nutritional regime. UUN:C ratios are used as indicators of winter nutrition in elk by determining whether or not the animal is catabolizing body protiens for energy.

CALF SURVIVAL

Because an objective of habitat enhancement is to increase elk productivity through increased survivability of calves, it is necessary that we develop an understanding of the factors affecting it. Toward this end we will make an effort next June to capture at least 6 neonatal calves for marking. They will be fitted with ear tag transmitters and monitored.

GEOGRAPHIC INFORMATION SYSTEM (GIS)

Aerial net gunning has afforded us the time opportunity to develop the use of GIS. This will entail the development of a base map and necessary layers for analysis such as roads, habitat types, and treatment areas. Many maps have already been digitized and are available, however, we need the time for familiarization with the program and the integration of our data into it.

DATA ANALYSIS

There remains much work to be done with existing collected data. Development of the sightability model, an analysis of relocations at Spotted Bear, analysis of ECODATA plots and other tasks have not been done.

FIVE-YEAR REPORT

As stipulated in the FY92-96 operating plan, a final report summarizing the activities and benefits for the five year period ending June 30, 1996 will be in draft form by april 30 and final by June 30. We will begin work on this report in October 1995.

REFERENCES CITED

Biggins, D.E. 1975. Seasonal habitat relationships and movements of the Spotted Bear elk herd. Montana Dept. Fish and Game Job Final Rept. Proj. No. W-120-R-6 and 7. Study No. BG-3.2, Job No. 1. 90pp.

Bissell, G.N., and C.A. Yde. 1985. Wildlife and wildlife habitat mitigation plan for Hungry Horse hydroelectric project. Prep. by Montana Dept. Fish, Wildlife and Parks for Bonneville Power Admin., Portland, OR. 90pp.

Casey, D.C., and Malta, P.R. 1990. Northwest Montana wildlife habitat enhancement: Hungry Horse elk mitigation project. Interim (Annual) Rept. Montana Dept. Fish, Wildlife and Parks, Kalispell. 85pp.

______, and ______. 1990b. Northwest Montana wildlife habitat enhancement: Hungry Horse elk mitigation project. Monitoring and evaluation plan. Montana Dept. Fish, Wildlife and Parks, Kalispell. 56pp.

______, and ______. 1990c. Hungry Horse dam wildlife habitat enhancement project: long-term habitat management plan elk and mule deer winter range enhancement Firefighter Mountain and Spotted Bear winter ranges. Montana Dept. Fish, Wildlife and Parks, Kalispell. 89pp.

______, and ______. 1991. Northwest Montana wildlife habitat enhancement: Hungry Horse elk mitigation project. Annual Rept., FY91. Montana Dept. Fish, Wildlife and Parks, Kalispell. 41pp.

______, and ______. 1992. Northwest Montana wildlife habitat enhancement: Hungry Horse elk mitigation project. Interim (Annual) Rept. Montana Dept. Fish, Wildlife and Parks, Kalispell. 66pp.

______, C.A. Yde, and A. Olsen. 1984. Wildlife impact assessment and summary of previous mitigation related to hydroelectric projects in Montana. Vol.III - Hungry Horse Project. Prep. by Montana Dept. Fish, Wildlife and Parks for Bonneville Power Admin., Portland, OR. 66p.

______, H. Rivera, S. Riley, J. Harper, T. Grotzinger, and H. Nyberg. 1988. Northwest Montana wildlife habitat enhancement: Elk/Mule deer winter range, Hungry Horse Reservoir. Prep. by Montana Dept. Fish, Wildlife and Parks and USDA Forest Service for Bonneville Power Admin., Portland, OR. 30pp.

Cole, G.F. 1959. Key browse survey method. Proc. Annu. Conf. West. Assoc. State Game and Fish Comm. 39:181-185.

DelGuidice, G.D, and U.S. Seal. 1988. Classifying winter undernutrition in deer via serum and urinary urea nitrogen. Wildl. Soc. Bull. 16:27-32.

______, L.D. Mech, and U.S. Seal. 1989. Physiological assessment of deer populations by analysis of urine in snow. J. Wildl. Manage. 53(2):284-291.

______, U.S. Seal, and L.D. Mech. 1991. Indicators of severe undernutrition in urine of free-rangeing elk during winter. Wildl. Soc. Bull. 19:106-110.

______, F.J. Singer, and U.S. Seal. 1991b. Physiological assessment of winter nutritional deprivation in elk of Yellowstone National Park. J. Wildl. Manage. 55(4):653-664.

DeSimone, R. and J. Vore. 1992. Elkhorn elk monitoring project: 1991 annual report. Mont. Dept. Fish, Wildl. and Parks. Helena. 110pp.

Hamlin, K.L. and M.S. Ross. 1992. Elk population dynamics and breeding biology: progress report 1992. Mont. Dept. Fish, Wildl. and Parks. Bozeman. 27pp.

Loft, E.R., and J.G. Kie. 1989. Comparison of pellet-group and radio-triangulation methods for assessing deer habitat use. J. Wildl. Manage. 52(3):524-527.

Montana Department of Fish, Wildlife and Parks. 1992. Statewide elk management for Montana. MDFWP, Helena. 170pp.

Mech, L.D., U.S. Seal, and G.D. DelGiudice. 1987. Use of urine in snow to indicate condition of wolves. J. Wildl. Manage. 51(1):10-16.

Mussehl, T., J. Gaffney, and D.G. Conklin. 1986. Design for tomorrow, 1985-1990: A strategic plan for Montana's fish, wildlife and park resources. Montana Dept. Fish, Wilflife and Parks, Helena. 88pp.

Neff, D.J. 1968. The pellet-group technique for big game trend, census, and distribution: a review. J. Wildl. Manage. 32:597-614.

Nelson, J.R, B.B. Davitt, and T. Hodgman. 1986. FY1986 progress report: DAPA cooperative research and development program. Department of Forestry and Range Manage., Washington Stae Univ., Pullman. 39pp.

Quimby, D.C., and J.E. Gaab. 1957. Mandibular dentition as an age indicator in Rocky Mountain elk. J. Wildl. Manage. 21:435-451.

Rice, W.R., and J.D. Harder. 1977. Application of multiple aerial sampling to a mark-recapture census of white-tailed deer. J. Wildl. Manage. 41(2):197-206.

Samuel, M.D., D.J. Pierce, and E.O. Garton. 1985. Identifying areas of concentrated use within the home range. J. Animal Ecol. 54(3):711-719.

______, E.O. Garton, M.W. Schlegel, and R.C. Carson. 1987. Visibility bias during aerial surveys of elk in northcentral Idaho. J. Wildl. Manage. 51(3):622-630.

Simmons, C.A. 1974. Seasonal movements and migrations of the Spotted Bear elk herd. M.S. Thesis. Univ. Montana, Missoula. 99pp.

Stickney, P.F. 1966. Browse utilization based on percentage of twig numbers browsed. J. Wildl. Manage. 30(1):204-206.

USDA Forest Service. 1985. Forest Plan: Flathead National Forest. USDA Forest Service. Kalispell, MT.

Van Etten, R.C., and C.L. Bennett. 1965. Some sources of error in using pellet-group counts for censusing deer. J. Wildl. Manage. 29(4):723-729.

Vore, J. 1990. Movements and distribution of some northern Yellowstone elk. M.S. thesis. Montana State Univ., Bozeman. 80pp.

______, and P.R. Malta. 1994. Hungry Horse Habitat Mitigation Project 1993 Annual Report. Montana Dept. of Fish, Wildl. and Parks. Kalispell. 62pp.

Zar, J.H. 1974. Biostatistical Analysis. Prentis-Hall, Inc. Englewood Cliffs, N.J. 620pp.

Appendix A. Marked elk of the Firefighter Mountain population as of 31 December 1994. Radio collars are black, neckbands are blue.

I.D.[a]	Sex/ Age[b]	Ear Tag	Date Marked	Trap Site	Status as of 31 December 1994
4004	F/3	92-109	02/03/93	HH3	Functional
4049	F/3	90-67	01/16/91	HHM	Functional
4082	F/2	92-107	01/20/93	HHM	Non-functional
4092	F/3	88-22	03/05/93	HH4	Functional
4099	M/2	93-131	12/15/93	RIV	Functional
4112	F/3	91-105	03/04/92	HHM	Functional
4129	F/3	92-108	01/28/93	HH4	Non-functional
4151	F/3	92-106	01/12/93	HHM	Functional
4158	F/4	91-103	02/12/92	EIO	Functional
4194	F/4	89-35	01/11/90	EBO	Functional
4271	F/3	99-101	01/15/92	FFC	Functional
4303	F/3	89-37	01/11/90	896	Functional
4315	F/1	93-127	12/20/93	EMC	Functional
4913	F/1	93-129	12/21/93	MAR	Functional
5042	F/3	88-29	02/24/93	HHM	Functional
5058	F/3	91-99	01/15/92	HHT	Functional
5087	F/3	89-56	03/19/93	FFC	Functional
5098	F/3	90-96	04/02/91	GPS	Functional
5117	F/2	92-111	03/19/93	FFC	Functional
5170	F/3	90-70	02/07/91	R16	Functional
5181	F/3	90-90	02/28/92	16S	Non-functional
5190	F/4	61-102	02/04/92	EIO	Functional
5205	F/3	90-71	02/08/91	GPS	Functional
5221	F/1	92-110	03/19/93	FFC	Non-functional
5232	M/2	90-72	02/08/91	EIO	Functional
5252	F/3	88-19	01/26/89	SRD	Non-functional
5282	F/3	90-74	02/08/91	HH3	Functional
5293	F/2	99-100	01/15/92	FFC	Functional

Continued.

Appendix A. Concluded.

I.D.[a]	Sex/ Age[b]	Ear Tag	Date Marked	Trap Site	Status as of 31 December 1994
5301	M/1	93-130	12/20/93	HHM	Functional
5320	F/3	90-76	02/13/91	R16	Functional
5331	F/3	90-78	02/14/91	GPS	Functional
5353	M/1	93-123	12/15/93	RIV	Functional
5360	F/3	90-75	02/12/91	HH3	Functional
5377	F/4	92-112	04/02/93	HH4	Functional
5390	F/3	NONE	03/26/93	FFC	Functional
NBLK// /[c]	F/3	88-31	04/06/89	HHM	Assumed alive
NB---	F/3	89-38	01/11/90	HHM	Assumed alive
NBOOOO	F/3	90-77	02/13/91	EIO	Assumed dead
NB	F/3	89-64	03/21/90	HHS	Assumed alive
NB>>>	F/3	89-65	03/21/90	EIO	Assumed dead
NBUUUU	F/4	90-92	03/22/91	GPS	Assumed dead
NB+++	F/4	89-66	03/28/90	MCG	Assumed alive
NBARR	F/1	NONE	04/02/91	EIO	Assumed alive
NBSQUR	M/2	90-97	04/03/91	GPS	Assumed alive
NBPDOT	F/1	90-98	04/03/91	EIO	Assumed dead
NBTRI	F/3	89-48	03/07/90	HHM	Assumed alive

[a] Radio frequency or necband symbol.
[b] Estimated age at marking. 1=calf, 2=yearling, 3=2½-6½, 4=≥7½
[c] This neckband is on black material.

Appendix B. Marked elk of the Spotted Bear population as of 31 December 1994. All are yellow with black symbols.

I.D.[a]	Sex/ Age[b]	Ear Tag	Date Marked	Trap Site	Status as of 31 December 1994
4010	F/2	93-114	12/14/93	LT	Functional
4041	F/1	93-113	12/21/93	SBM	Functional
4180	F/3	93-120	12/14/93	DP	Functional
4232	M/2	93-117	12/14/93	DP	Functional
5004	F/3	87-03	01/21/88	HR	Functional
5010	F/3	90-79	02/23/91	DR	Functional
5022	F/1	93-116	12/14/93	DP	Functional
5033	F/3	87-07	01/24/88	SP	Non-functional
5044	F/3	90-81	02/24/91	PB	Functional
5066	F/2	90-115	12/21/93	SB	Functional
5103	F/3	87-08	01/24/88	DR	Non-functional
5160	F/3	87-15	02/25/88	SP	Non-functional
NYWAV	F/4	88-27	03/10/89	BR	Assumed alive
NYCHK	F/4	89-55	03/12/90	PB	Assumed alive
NYUUU	F/2	89-54	03/12/90	PB	Assumed dead
NY¦-¦-	F/3	90-80	02/24/91	PB	Assumed alive
NY888	F/4	89-42	01/22/90	BR	Assumed dead
NY333	F/4	90-86	02/24/91	PB	Assumed dead
NYH H	F/3	89-62	03/13/90	PB	Assumed alive
NYARR	F/3	89-41	01/21/90	PB	Observed 09/09/93
NY+O	F/4	A1128	03/12/90	PB	Assumed dead
NY/-/	M/1	89-61	03/13/90	PB	Assumed dead
NYXXX	F/3	89-52	03/12/90	PB	Assumed alive
NYHRGL	F/3	89-53	03/12/90	PB	Assumed alive
NY¦¦¦	F/3	89-49	03/12/90	PB	Assumed alive
NYPDOT	F/3	89-51	03/12/90	PB	Assumed dead
NYTTT	F/2	89-57	03/13/90	PB	Assumed dead
NY====	F/3	90-84	02/24/91	PB	Assumed alive
NY%%%	F/2	89-59	03/13/90	PB	Assumed dead
NYEEE	F/3	89-60	03/13/90	PB	Assumed dead

[a] Radio frequency or necband symbol.

[b] Estimated age at marking. 1=calf, 2=yearling, $3=2\frac{1}{2}-6\frac{1}{2}$, $4=\geq 7\frac{1}{2}$

Appendix C. Summary of winter (Dec.-May) elk classifications on Firefighter Mountain, 1988-1994.

Date	Type[a]	Total	Cows	Calves	Bulls			Per 100 Cows[c]	
					BAB	Spk	Uncl♂[b]	Calves	Bulls
1993/94									
01/12	FW	60	26	7	1	0		26.9	3.8
02/04	FW	65	4	3	0	0			
02/16	FW	59	24	13	1	3		54.2	4.2
03/02	FW	53	14	5	0	2			
03/18	FW	81	44	20	7	3		45.4	22.7
04/08	FW	70	45	11	2	2		24.4	8.8
04/26	HEL	42	25	10	3	0	4	40.0	28.0
05/14	FW	54	12	2	1	0			
06/29	FW	19	10	3	4	0			
TOTAL		503	204	74	19	14		36.6	15.7
1992/93									
03/04	HEL	10	7	3					
03/04	FW	17	12	4	1				
03/30	FW	56	37	14	1	2	2	37.8	13.5
04/06	FW	39	29	5	1	1	3	17.2	17.2
04/06	HEL	44	29	12		2	1	41.4	10.3
04/07	HEL	43	32	7	3	1		21.9	12.5
04/27	HEL	63	39	12		5	7	30.8	30.8
05/06	FW	37	27	7		1	2	25.9	11.1
TOTAL		309	212	64	6	12	15	30.2	15.6

Date	Type[a]	Total	Cows	Calves	Bulls			Per 100 Cows[c]	
					BAB	Spk	Uncl♂[b]	Calves	Bulls
1991/92									
01/17	FW	57	41	11	1	4		26.8	12.2
02/11	FW	48	31	12	1	4		38.7	16.1
02/25	FW	51	37	10	3	1		27.0	10.8
03/13	FW	75	49	20	5	1		40.8	12.2
03/27	FW	65	46	13	5	1		28.3	13.0
04/07	FW	16	7	4	4	1			
04/14	HEL	67	36	19	5	3	4	52.7	33.3
TOTAL		379	247	89	24	15	4	36.0	17.4
1990/91									
01/03	FW	22	17	4	0	1			
01/18	FW	22	15	6	0	1			
01/22	FW	47	29	16	2	0		55.2	6.9
02/06	FW	25	20	3	0	2		15.0	10.0
03/21	FW	51	31	9	6	5		29.0	35.5
03/30	FW	101	54	30	7	10		55.5	31.5
04/19	HEL	67	38	21	2	5	1	55.3	21.0
04/19	HEL	45	25	10	2	6	2	40.0	40.0
05/04	HEL	38	27	11				40.7	0
TOTAL		418	256	110	19	30	3	43.0	20.3
1989/90									
12/13	FW	84	51	27	0	6		52.9	11.8
01/12	FW	27	14	8	1	4		57.1	35.7
02/14	FW	39	28	10	0	1		35.7	3.6
03/06	FW	73	41	27	1	4		65.8	12.2
03/21	FW	40	24	12	0	4		50.0	16.7
04/18	FW	69	39	14	4	2	10	35.9	41.0
05/01	FW	33	22	7		1	3	31.9	12.1
TOTAL		365	219	105	6	22	13	45.7	18.7

Date	Type[a]	Total	Cows	Calves	Bulls			Per 100 Cows[c]	
					BAB	Spk	Uncl♂[b]	Calves	Bulls
1988/89									
11/30[d]	FW	47	28	14	5			40.0	30.0
04/18	FW	34	20	8	1	4	1	50.0	17.9
TOTAL		81	48	22	6	4	1	45.9	22.9
1987/88									
03/11	FW	16	13	1		2			
03/18	FW	23	14	3	1	5			
04/01	FW	28	23	5				21.7	0
04/09	FW	30	21	7	1	1		33.3	9.5
04/16	FW	90	58	26	3	3		44.8	
TOTAL		187	129	42	5	11		32.6	12.4

[a] FW=fixed wing, HEL=helicopter

[b] Bulls with dropped antlers

[c] Ratios given only when total $n \geq 25$

[d] One day before December but is included here

Appendix D. Number of fresh and recent elk pellet groups observed on transects, 1988-1994, Firefighter Mountain.

Transect Type and	Number	Year 88	89	91	92	93	94	Mean
Treatment:	14	3	0	1	0	0	2	1.0
	33			2				2.0
	36			0			1	0.5
	54			0	0	0	0	0.0
	57			0	0			0.0
	58			0	0			0.0
	A			0	1	0	6	1.8
	B			0	0	0	0	0.0
	C			1	1	1	0	0.8
	D		1	2	0	1	1	1.0
	E			2	4	1	6	3.3
	F		0					0.0
	G			24			13	18.5
	J	36	9	11	24	25	19	20.7
	L					14		14.0
	M		8	8	5	7	5	6.6
Random:	1	1						1.0
	3	1	0	0	1	0	1	0.5
	4	8	4	14	0	0	0	4.3
	5	4	1	2	1	3	1	2.0
	6	1	1	3	0	0	0	0.8
	7	2	1	0	0	0	0	0.5
	9	0		4	0	3	2	1.8
	10	1		7	4	1	0	2.6
	11	1		0	1	1	0	0.6
	12	6	2	1	1	4	1	2.5
	13	1	3	4	5	3	2	3.0
	15	1	0					0.5

Continued

Appendix D. Concluded.

Transect Type and Number		Year 88	89	91	92	93	94	Mean
Random:	16	0	7	11	9	10	4	6.8
	17	5		19	7	3	0	6.8
	19		7		4	2	1	2.8
	20		6			4		5.0
	21		0	0	0	1	0	0.2
	23		3	1	0	2		1.5
Control:	2	0	0	0	0	0	0	0.0
	27C			0	5	1	2	2.0
	36A			1	1	1	1	1.0
	AC	0	0	0	1	4	5	1.7
	BC	0	0	0	0	0	0	0.0
	CC		2	0	0	2	2	1.2
	EC		0	3	0	0	0	0.6

Appendix E. List of plants encountered on ECODATA plots, Firefighter Mountain winter range area.

Scientific binomial		Abbrev	Common Name
TREES:			
Abies	*lasiocarpa*	ABILAS	subalpine fir
Larix	*occidentalis*	LAROCC	Western larch
Pinus	*contorta*	PINCON	lodgepole pine
Pinus	*monticola*	PINMON	Western white pine
Pseudotsuga	*menziesii*	PSEMEN	Douglas fir
SHRUBS:			
Acer	*glabrum*	ACEGLA	Rocky Mountain maple
Alnus	*sinuata*	ALNSIN	Sitka alder
Alnus	*tenuifolia*	ALNTEN	thinleaf alder
Alnus	spp.	ALNUSX	alder spp.
Amelanchier	*alnifolia*	AMEALN	Western serviceberry
Arctostaphylos	*uva-ursi*	ARCUVA	kinnikinnick
Berberis	*repens*	BERREP	creeping Oregon grape
Betula	*tenuifolia*	BETTEN	paper birch
Ceanothus	*sanguinus*	CEASAN	redstem ceanothus
Ceanothus	*velutinus*	CEAVEL	evergreen ceanothus
Cornus	*stolonifera*	CORSTO	red-osier dogwood
Holodiscus	*discolor*	HOLDIS	creambush oceanspray
Juniperus	*communus*	JUNCOM	common juniper
Linnaea	*borealis*	LINBOR	Western twinflower
Lonicera	*utahensis*	LONUTA	Utah honeysuckle
Menziesia	*ferruginea*	MENFER	fool's hucklebery
Pachistima	*myrsinites*	PACMYR	myrtle boxwood
Potentilla	*argentea*	POTARG	silver cinquefoil
Prunus	*emarginata*	PRUEMA	bittter cherry
Prunus	spp.	PRUNX	cherry spp.
Prunus	*virginia*	PRUVIR	common chokecherry
Ribes	spp.	RIBESX	currant
Rosa	spp.	ROSAXX	rose spp.
Rubus	*parviflorus*	RUBPAR	thimbleberry
Salix	spp.	SALIXX	willow spp.
Sambucus	spp.	SAMBUX	elderberry
Shepherdia	*canadensis*	SHECAN	buffaloberry

continued.

Appendix E continued.

Scientific binomial		Abbrev	Common Name
Sorbus	*scopulina*	SORSCO	mountain ash
Spiraea	*betulifolia*	SPIBET	shiny-leaf spirea
Symphoricarpus	*albus*	AUMALB	common snowberry
Taxus	*brevifolia*	TAXBRE	Pacific yew
Vaccinium	*caespitosum*	VACCAE	dwarf huckleberry
Vaccinium	*globulare*	VACGLO	globe huckleberry
Vaccinium	spp.	VACCIX	huckleberry spp.
GRASSES:			
Agropyron	spp.	AGROPX	wheatgrass
Calamagrostis	*rubescens*	CALRUB	pinegrass
Carex	spp.	CAREXX	sedge
Festuca	*idahoensis*	FESIDA	Idaho fescue
Phelum	*pratense*	PHEPRA	timothy
		GRASSX	grass
FORBS:			
Achillea	*lanulosa*	ACHLAN	yarrow
Adenocaulon	*bicolor*	ADEBIC	trail-plant
Agoseris	spp.	AGOSER	false dandelion
Allium	spp.	ALLIUM	onion
Anaphalis	*margaritacea*	ANAMAR	pearly everlasting
Antennaria	*microphylla*	ANTMIC	rosy pussytoes
Antennaria	*neglecta*	ANTNEG	pussytoes
Antennaria	*racemosa*	ANTRAC	raceme pussytoes
Apocynum	spp.	APOCYN	dogbane
Arabis	spp.	ARABIS	rock cress
Aralia	*nudicaulis*	ARANUD	wild sarsaparilla
Arnica	*latifolia*	ARNLAT	mountain arnica
Aster	spp.	ASTERX	aster
Calochortus	*apiculatis*	CALAPI	Baker's mariposa lily
Campanula	spp.	CAMPAN	harebell
Chimaphila	*unbellata*	CHIUMB	common prince's pine
Clematis	spp.	CLEMAT	clematis

continued.

Appendix E continued.

Scientific binomial		Abbrev	Common Name
Clintonia	*uniflora*	CLIUNI	queen's cup
Cornus	*canadensis*	CORCAN	bunchberry
Crucifereae	spp.	CRUCIF	mustard
Disporum	*hookeri*	DISHOO	Hooker fairy-bell
Disore	*oreganum*	DISORE	fairy-bell
Epilobium	spp.	EPILOB	willow herb
Erigeron	*acris*	ERIACR	bitter fleabane
Erigeron	*divergens*	ERIDIV	diffuse fleabane
Filago	*arvensis*	FILARV	fluffweed
Fragaria	spp.	FRAGAR	strawberry
Gallium	*boreale*	GALBOR	Northern bedstraw
Gallium	*triflorum*	GALTRI	sweet-scented bedstraw
Goodyera	*oblongifolia*	GOOOBL	rattlesnake-plantain
Habenaria	*elegans*	HABELE	elegant rain-orchid
Heuchera	*cylindrica*	HUECYL	roundleaf arum-root
Hieracium	*albiflorum*	HIEALB	white hawkweed
Hieracium	*albertinum*	HIEALB	Western hawkweed
Hypericum	*perforatum*	HYPPER	St. John's -wort
Listera	*chordata*	LISCHO	heart-leaf twayblade
Lupine	spp.	LUPINU	lupine
Melampyrum	*linerea*	MELLIN	narrow-leaved cow-wheat
Osmorhiza	*chilensis*	OSMCHI	mountain sweet-root
Pedicularis	*racemosa*	PEDRAC	sickletop lousewort
Penstemon	spp.	PENSTE	penstemon
Potentilla	*argentea*	POTARG	silver cinquefoil
Prunella	*vulgaris*	PRUVUL	self-heal
Pterospora	*andromecea*	PTEAND	woodland pinedrops
Pyrola	spp.	PYROLX	wintergreen
Sedum	*stenopetallum*	SEDSTE	wormleaf stonecrop
Senecio	*triangularis*	SENTRI	arrowleaf groundsel
Smilacina	*stellata*	SMISTE	starry solomon-plume
Spiranthus	*romanzoffiana*	SPIROM	hooded ladies-tresses
Thalictrum	*occidentalis*	THAOCC	Western meadowrue
Tiarella	*uniflora*	TIAUNI	coolwort foamflower
Veronica	*catenata*	VERCAT	white wake-robin
Veratrum	*viride*	VERVIR	speedweed

continued.

Appendix E concluded.

Scientific	binomial	Abbrev	Common Name
Viola	*adunca*	VIOADU	early blue violet
Viola	spp.	VIOLAX	violet
Viola	*orbiculata*	VIOORB	round-leafed violet
Xerophyllum	*tenax*	XERTEN	beargrass
FERNS:			
Athyrium	*filix-femina*	ATHFIL	ladyfern
Gymnocarpium	*dryopteris*	GYMDRY	oakfern
Pedicularis	*bracteosa*	PEDBRA	bracted lousewort
Pteridium	*aquilinum*	PTEAQU	brackenfern

Appendix F. Status of treatment units on Firefighter Mountian as of 31 December 1994.

Unit	Treatment	Status
A	Harvest	Cut summer 1992, burned spring 1994
D	Harvest	Cut summer 1992, burned spring 1994
F	Slash/Burn	Slashed summer 1993, burned spring 1994
G	Pres. Burn	Slashed Aug. 1991, burned Mar. 1992
H	Pres. Burn	Slashed Aug. 1991, burned Mar. 1992
I	Pres. Burn	Slashed Aug. 1991, burned Mar. 1992
J	Pres. Burn	Slashed Aug. 1991, burned Mar. 1992
K	Pres. Burn	Burned Mar. 1992
L	Pres. Burn	Slashed Aug. 1991, burned Mar. 1992
M	Pres. Burn	Slashed Aug. 1991, burned Mar. 1992
1	Slash/Burn	1995-96
2	Harvest	Postponed
3	Harvest	1995-96
4	Harvest	Postponed
6	Harvest	1995-96
9	Slash	Slashed summer 1993
10	Harvest	1995-96
11/62*	Slash/Burn	Slashed summer 1993
12	Harvest	1995-96
14	Harvest	1995-96
15	Harvest	1995-96
16	Slash	Slashed summer 1993
17	Harvest	1995-96
18	Slash/Burn	Slashed summer 1993
21	Slash/Burn	Slashed summer 1993, burned spring 1994
22	Slash/Burn	Slashed summer 1993, burned spring 1994
23	Harvest	Postponed
24	Harvest	1995-96
25	Harvest	Postponed

Continued

Unit	Treatment	Status
26	Harvest	Postponed
27	Slash/Burn	Slashed fall 1993
28	Harvest	Cut summer 1993
29	Slash/Burn	Slashed fall 1993
31	Slash	Slashed summer 1991
33	Slash	Slashed summer 1991
34	Harvest	Cut summer 1993, burned spring 1994
35	Slash	Slashed summer 1991
36	Harvest	Cut summer 1993, burned spring 1994
37	Slash	Slashed summer 1991
38	Harvest	Cut summer 1993
39	Harvest	Deferred to next decade
42	Harvest	Cut summer 1993, burned spring 1994
44	Harvest	Cut summer 1993
47	Harvest	Cut summers 1992-93, burned May 1994
48	Harvest	Cut summer 1993
49	Slash	Slashed summer 1993
50	Harvest	Cut summer 1993
51	Harvest	Cut summer 1992, burned spring 1993
52	Harvest	Cut summer 1992, burned spring 1993
53	Harvest	Cut summer 1993
54	Harvest	Cut summer 1993
55	Harvest	Cut summers 1993-94
56	Harvest	Deferred to next decade
57	Slash/Burn	Postponed
58	Harvest	Cut summer 1993
60	Harvest	Cut summer 1993
61	Harvest	Cut summer 1993
63	Pres. Burn	Burned Mar. 1993
64	Harvest	Cut summer 1993

Continued

Unit	Treatment	Status
66	Harvest	Cut summer 1993
69	Harvest	Cut summer 1993
70	Harvest	Cut summer 1993
71	Harvest	Cut summer 1993, burned spring 1994
82(B)	Harvest	1995-96
83(C)	Harvest	Cut summer 1993
85(E)	Harvest	Cut summer 1993

Units 11 and 62 were combined into one treatment area.